Distortion of the SIS18 DC Transformer GS01DT_ML after relocation from section 7 to section 1

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1 Introduction

The Parametric Current Transformer (PCT) by Bergoz has been moved from section 7 to section 1 of the SIS18 synchrotron to make space for cavities. The PCT is now called GS01DT_ML1. We briefly report on the influence of the dipole stray field on the PCT output signal in the new installation position. A simple software correction scheme is suggested which is similar to the one established at the HIT synchrotron.

2 Signal Distortion by Dipole Ramp

2.1 Data Acquistion and Treatment

Three cycles of GS01DT_ML and dipole current were recorded in ABLAXX in relative units during a Xenon (Xe 43+, 300 MeV/u) beam time for HTP detector tests at a sampling rate of 1 kHz. The beam intensity was reduced to $5x10^6$ particles in the SIS18 or 83 μA at flat top. The measurement of the transformer was set to 20 mA. We therefore disregard the small DC current in this simple analysis.
The data of Figure 1 were treated in the following way:

- Both signal traces were offset corrected using the final part of the data (3650-3700 ms) where no beam is left in the SIS18 and the dipole has ramped down.
- The transformer signal was normalised to 1.6 mA using the "empty cycle" data of the measurement protocol of 19th June.
- The dipole signal was normalised to the transformer signal using the flat top region (2000-2100 ms).
- The data of three SIS18 cycles were averaged.

2.2 Result

Figure 1 shows the two normalised signals of the 7.74 Tm synchrotron cycle together with the difference signal which was multiplied by a factor of 5 for better illustration. The dipole signal shape matches that of the transformer signal quite well. In the previous installation postion the transformer signal has been influenced also by other magnets.
A small discrepancy of 40 μA (not scaled by x5!) is detectable at the injection flat top. During the ramping times systematic deviations in the range of 0.15/0.1 mA (not scaled!) at the start/end of the cycle occur. Similar observations have been reported in [1] for the HIT current transformer which however suffers from bigger stray field distortions from dipole and sextupole magnets.

Scaling the value of 1.6 mA to the 600 MeV/u data yields an estimated current distortion of 2.4 mA which is in reasonable agreement with the measured value of 2.15 mA (see data of 14th June in section 3). For the maximum rigidity of 18 Tm, the distortion would be about 3.3 mA or 16% full scale in the 20 mA range. The estimated field correction factor is about 1800 $\mu A/T$ (=3.3 mA/1.8 T).
In comparison the GSI DCT transformer GS09DT_ML has a field correction factor of 5.5 $\mu A/T$ which yields a maximum distortion of 10 μA (B_{max}=1.8 T). The factor is about 330 times smaller than the one of the Bergoz transformer!

For typical DC beam currents of SIS18 operation and, in the future, for the beam modes "pilot beam" and "intensity ramp-up" of the new control system (and for beam delivery to the target hall limited by radiation protection shielding) the Bergoz transformer GS01DT_MLwould be regularly operated in this range. For "standard" purposes the remaining discrepancy during the ramping process after a simple "dipole correction" would be fully acceptable. The dipole ramp merely needs to be made available to the front-end acquisition system prior to the cycle via the LSA data supply.

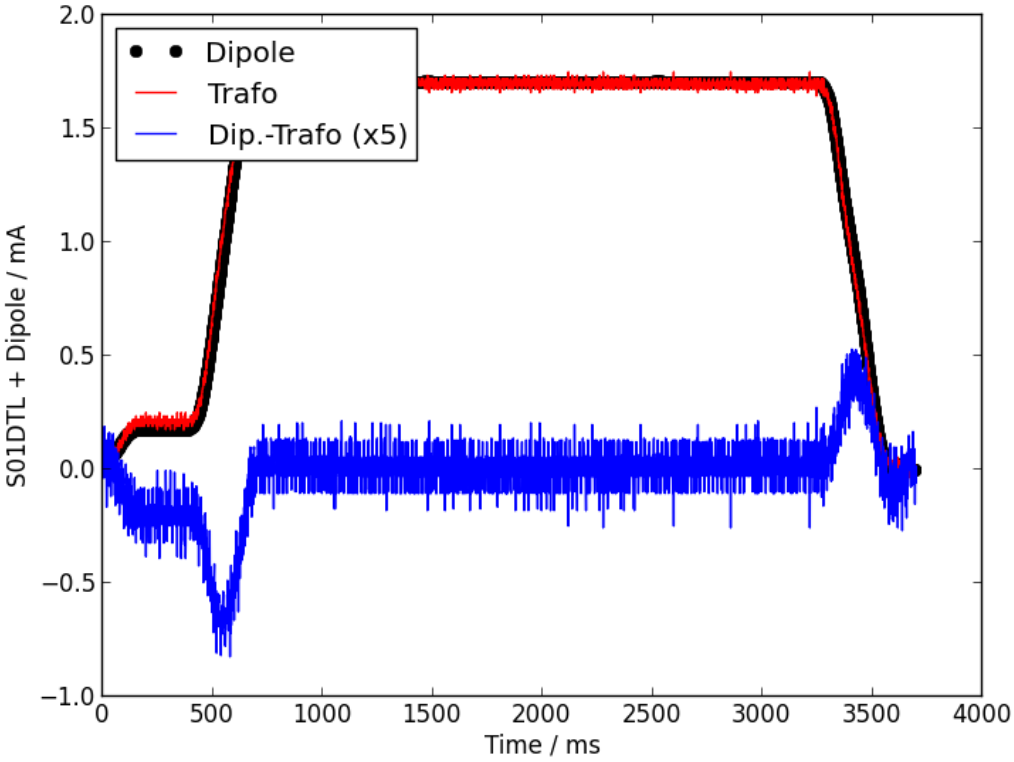


Figure 1: Signal distortion of GS01DT_ML output signal by dipole current for a magnetic rigidigy of 7.74 Tm. The dipole curve (black dots) has been normalised to the transfomer reading (red trace) at flat top. The difference signal (blue trace) has been multiplied by a factor 5 to enhance the remaining discrepancy along the dipole ramps.

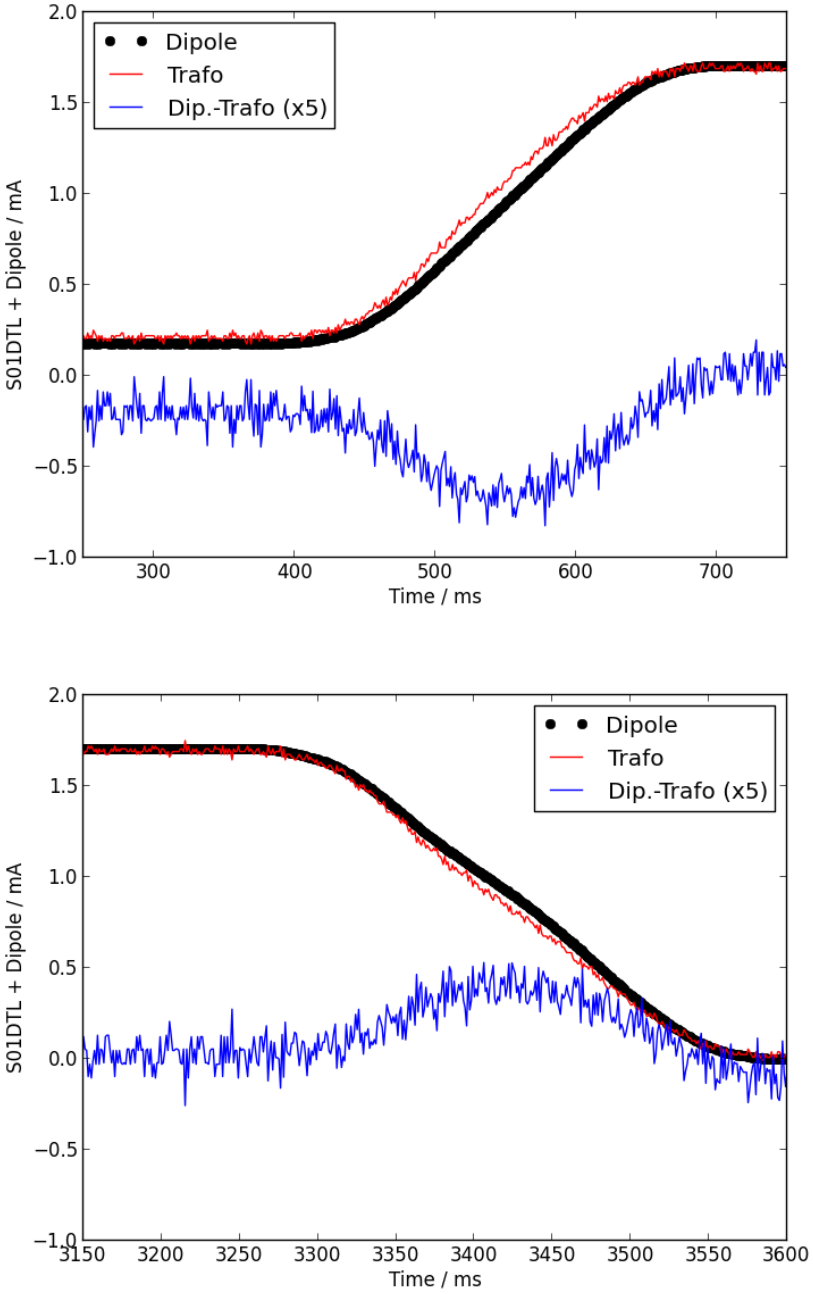
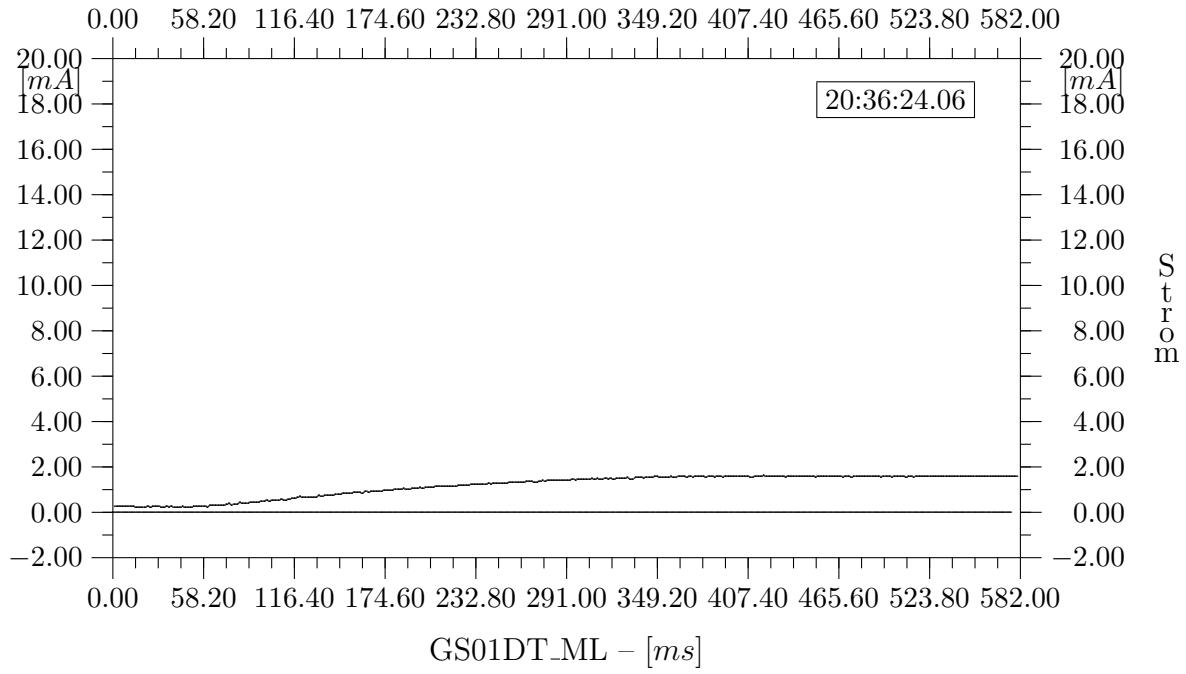


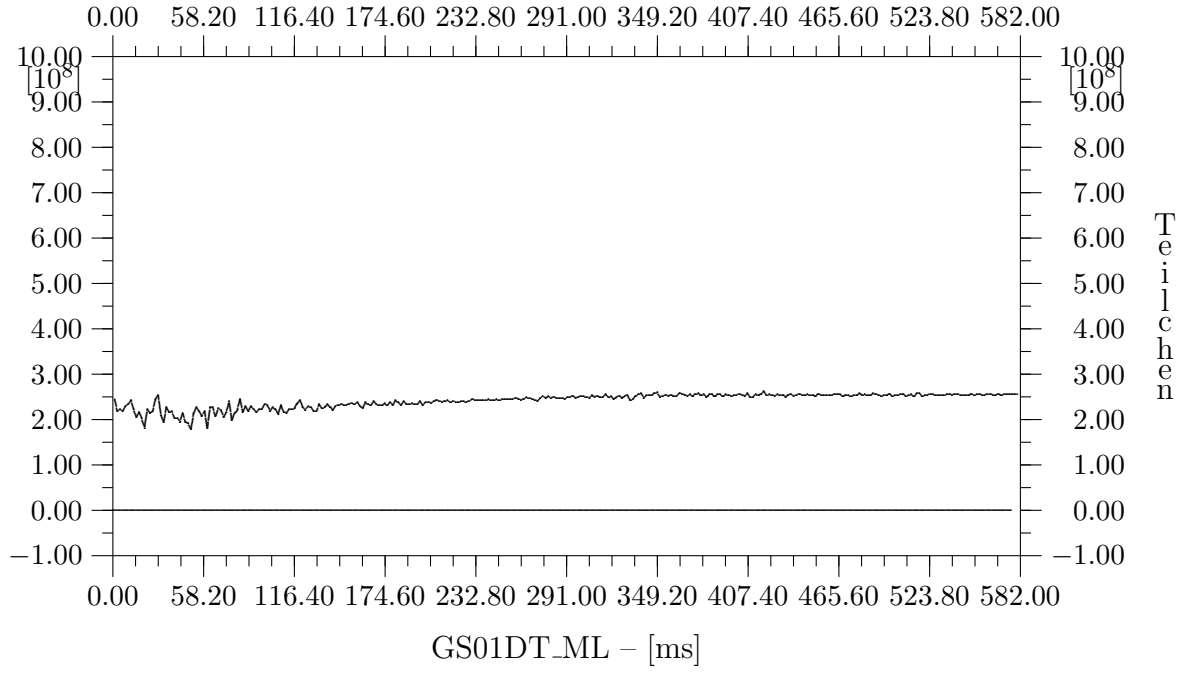
Figure 2: Signals of Figure 1 of the acceleration period at the cycle start (top) and dipole ramp down period at the cycle end (bottom).

3 GSI Transformer Protocols

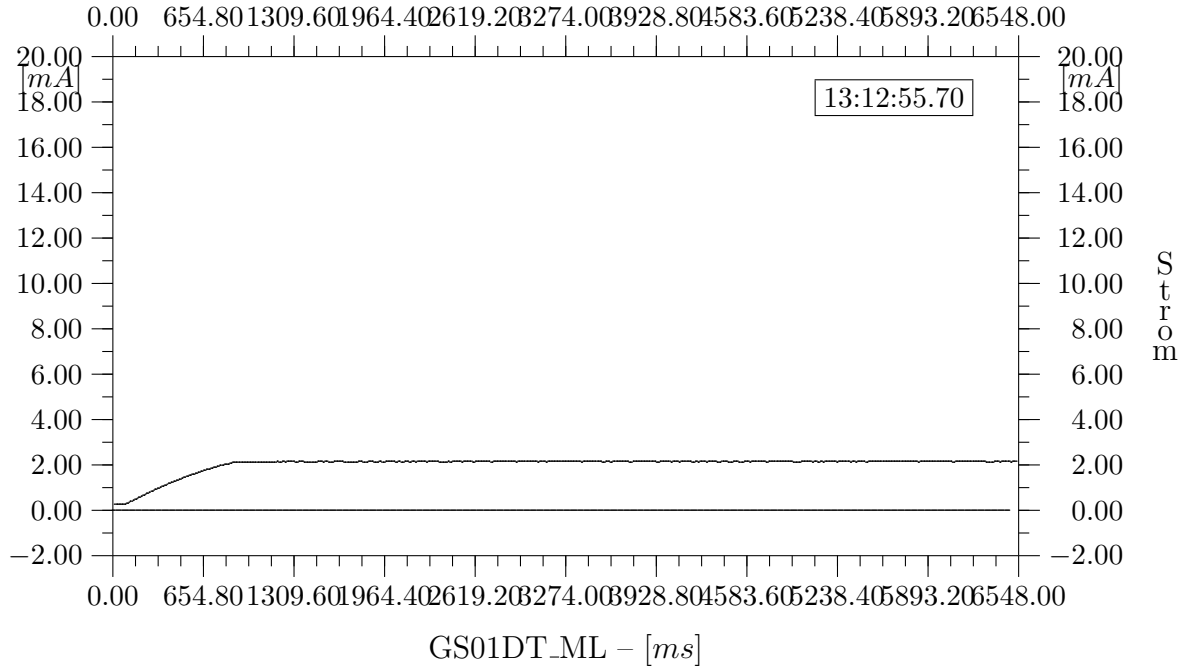
Two "empty" SIS18 cylces were recorded at different magnetic rigidities $B\rho$ and different days during the Xenon beam time. The data serve for normalisation of the ABLAXX data that was recorded in arbitrary units.

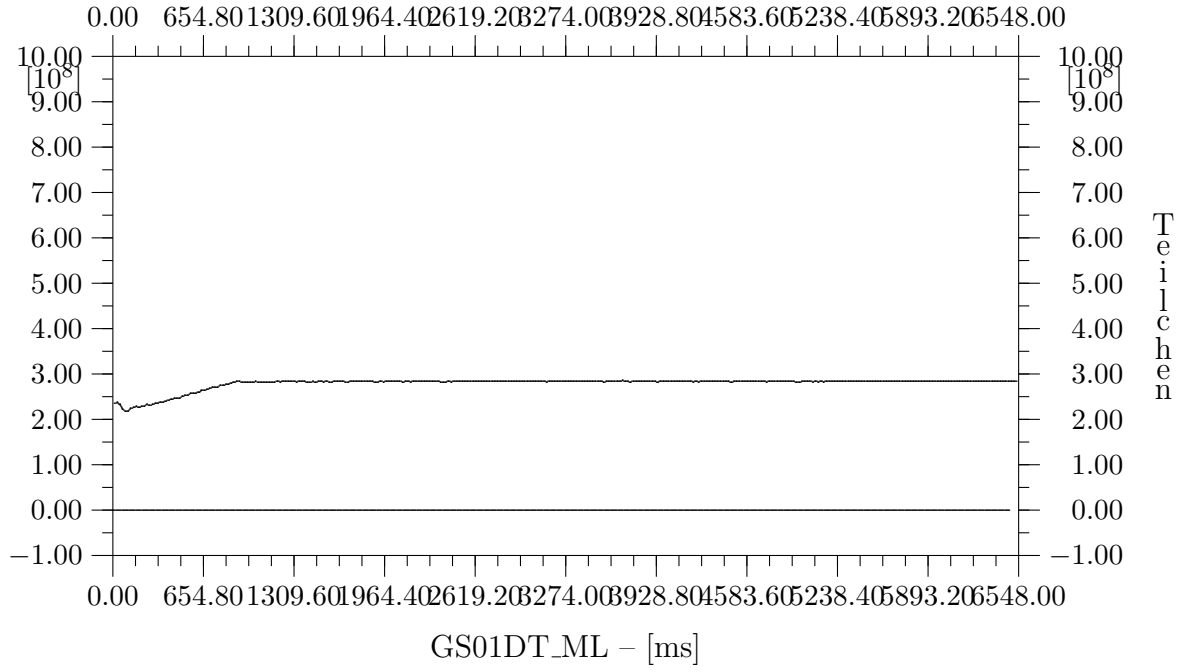
- HTP — S10 — $^{124}XE^{43+}$ — 300.000 MeV/u, 19.Jun 16 20:36:03, $B\rho = 7.74$ Tm
- HFS — S08 — $^{124}XE^{43+}$ — 600.000 MeV/u, 14.Jun 16 13:13:20, $B\rho = 11.7$ Tm





Gain	4		
Delay	2.00ms	Average	1
StromWert	1.58mA		529.8ms nach Me”sstart
TeilchenZahl	$2.54{\cdot}10^8$		





Gain	4		
Delay	2.00ms	Average	16
StromWert	2.15mA		6035.7ms nach Me"sstart
TeilchenZahl	$2.84 \cdot 10^8$		

4 Conclusion

- The distortion of the Bergoz transformer GS01DT_ML in the SIS18 synchrotron has increased by a factor 5-10 in the new installation location. The magnetic field correction factor is about 1800 $\mu A/T$ to be compared to the value of 5.5 $\mu A/T$ for the transformer GS09DT_ML.

- A software correction is suggested - at least for the 20 mA range - to compensate for this effect by a simple transformation of the dipole current value. The scheme includes one offset and one scaling parameter. The two values can be derived easily from "empty" cycle data recoreded at different magnetic rigidities.

References

[1] A. Reiter, *Untersuchung der Störeinflüsse auf das Signal des Transformators S5DTL im Synchrotron der HIT-Beschleunigeranlage*, Internal Report GSI, Oktober 2008